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THE SUPPOSED "SPONGE SPICULES" OF MERRILL, 1895, FROM THE LOWER CRETACEOUS (ALBIAN) OF TEXAS

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INTRODUCTION

In 1895, a paper was published by J. A. Merrill giving the results of a study of chert nodules from Texas. In this he described and figured a number of microscopic structures which were interpreted as sponge spicules and referred, hesitantly, to six known genera; eight new species were proposed, all of which were doubtfully attributed to the living genus *Geodia*.

This work escaped attention until 1945, when Glaessner noted that the supposed spicules of *Geodia* were in fact hystrichospherids (p. 20). As such, they constitute the first Lower Cretaceous hystrichosphere assemblage and hence the first record of Mesozoic dinoflagellate cysts from the United States. Subsequently, the present author proposed the provisional reallocation of Merrill's species, on the basis of study of his figures and descriptions, to various dinoflagellate cyst genera (Sarjeant, 1964, p. 175).

Through the courtesy of Dr. H. B. Whittington, the author has been permitted to examine Merrill's type material, from the collections of the Museum of Comparative Zoology, Harvard. The results of this study are presented here.

STRATIGRAPHY AND MATERIAL

The specimens studied by Merrill were nodules of chert collected by Mr. Edward E. Cauthorne from "a quarry near Austin, Texas." They were obtained from the Caprina Chalk (now known as the Edwards Limestone), a member within the

Fredericksburg Formation, Comanchean Stage. This formation is considered to be equivalent to the middle and the lower part of the Upper Albian of Europe (Murray, 1961, p. 349).

The material in the Harvard collections consisted of three slides and seventeen partial nodules or slices of chert (MCZ 185A). Two of the three slides measure 2″ by 1″ and bear sections of flint cut to a thickness of between two and three times that of a normal petrological section (0.03 mm); these were unlabelled and are here referred to as slides I and II. The third slide consisted of a square of glass measuring 3″ by 2″ by ¼″ thick, bearing a wedge-shaped chert slice (varying in thickness from approximately eight times to approximately twice the thickness of a normal petrological section) which was surrounded by Canada balsam in an irregular ring. The shape of the balsam ring indicated that the chert slice had originally been fully twice its present size, but that one half had become detached and lost at some period. The thickness of the glass mount was too great to permit satisfactory examination; the surviving portion of chert was therefore remounted for study (slide III).

Merrill states that "several slides" were made from each nodule; it is therefore possible, in absence of any clear labelling, that the three surviving slides do not contain the holotype material of his species. As will be detailed later, a number of specimens showed a general correspondence to one or other of Merrill's figures, but the figures are unaccompanied by photographs and are not drawn with sufficient accuracy to permit any certain linking of specimen to figure. There remains a residue of figures which do not correspond even in a general fashion to any specimen located; it must be presumed in these cases, either that the holotypes were contained in other slides now lost, or that they were contained in the missing half of flint section III.

With Dr. Whittington's courteous permission, sections were made from the remaining chert specimens. Nine further mounts were made and examined (slides IV-XII); they were cut to a thickness of between three times and twice that of a normal petrological section. It was hoped that the lithological character would prove sufficiently variable to enable correlation of the new with the old slides and thus to link the latter to their source nodules; unfortunately, this did not prove possible, the sections showing insufficient distinctive features.

Merrill also mentions (p. 10) having made a comparative study of English cherts; three sections were made by Merrill, but these proved virtually barren of microorganisms and thus

cannot correspond to the surviving slides. Similarly, since English cherts are not mentioned on the specimen label, it must be assumed that the surviving chert specimens are entirely from Texas.

GENERAL DISCUSSION OF MERRILL'S RESULTS

The earliest studies of microfossils in chert flakes were made by C. G. Ehrenberg, in 1836; he assumed wrongly that the hystrichospheres were silicified and placed them in the freshwater desmid genus *Xanthidium*. The name "xanthidia" was used also in descriptions of similar fossils by a group of English microscopists, but G. A. Mantell conclusively demonstrated their organic rather than siliceous composition and thus precluded placing them in *Xanthidium* (1845).

Merrill was clearly unaware of these earlier studies and repeated Ehrenberg's error of assuming his microfossils to be silicified. He states (p. 8): ". . . we must suppose either that the spicules have been replaced by amorphous silica, or that they are still in the hyaline or colloidal state as found, and coloured yellow by some organic agent perhaps." He noted the presence in the cherts of foraminifera (rotaliids and textularids), either as "ghosts" entirely replaced by silica, or with the organic shell linings persisting; the latter he described as ". . . replaced by amorphous silica, the outlines remaining in a dark substance which has the appearance of an organic residue." This is one of several indications that Merrill was unaware of, or discounted, the possibility of structures formed of organic substances incorporated into the cherts and persisting almost unchanged. He effectively assumed the whole microfossil content of the chert sections to be originally siliceous or secondarily silicified. This attitude clearly orientated his thinking during his study, for, as will be shown in the ensuing section, the microfossils he described as sponge spicules include spores, pollen, hystrichospheres, wood and plant fragments, and even carbonate crystals.

Merrill noted the relatively low concentration of microfossils in the chert (p. 6): ". . . the number of organic remains is few, and the massive silica greatly in excess." This comment is wholly endorsed by the present author; the number of microfossils other than Foraminifera encountered in the nine new slides (IV-XII) averaged less than two. Foraminifera were comparatively abundant, averaging more than a dozen per slide.

DISCUSSION OF THE FORMS FIGURED BY MERRILL

In the presentation of his results, Merrill described the forms sequentially according to their arrangement in his plate (here reproduced as Text-fig. A). This procedure is again followed here: the numbers, and names given by Merrill (in quotes), are first stated, and a reinterpretation of the specimens follows.

1. and 2. "Monactinellid: *Axinella* ? sp." The figured specimens were not relocated; however, they appear to consist of sections through shell fragments which have been entirely replaced by silica. Merrill noted (p. 7) the finding of supposed shell fragments replaced by silica, but described them as a "bright transparent yellow" and thus was probably misinterpreting organic tissue fragments.

3. and 4. "Monactinellid: *Reniera* ? sp." Also probably oblique sections through shell fragments replaced by silica. The figured specimens were not positively relocated, but a number of similar fragments were noted.

5. "Monactinellid; acuate spicule." Neither description nor figure is sufficiently informative to permit either certain recognition of the figured specimen or precise determination of its true nature. However, it is most probably a fragment of organic tissue (?plant); such fragments are quite common in the cherts.

6. "Monactinellid." The figure and description support the presumption that this is a wood fragment; such fragments occur infrequently in the cherts.

7. "Monactinellid." Described by Merrill (p. 13) as "the most abundant of the sponge spicules found in the flint"; microorganisms of this type, varying considerably in the detail of size and shape, were encountered in all twelve cherts examined; the figure is not adequate to permit certain recognition of the holotype. The presence of septae crossing the cone at right angles to its long axis makes it probable that these are the shell linings of unilocular foraminifera (Pl. 1, fig. 1).

8. "Monactinellid." Also most probably a wood fragment; not relocated.

9. "Monactinellid: *Esperites* ? sp." Although stated by Merrill to be "a very common form" (p. 13), this figure was not correlated with certainty with any microstructure seen in the slides. It may possibly represent a replaced shell fragment or a fragment of organic tissue.

10. "Monactinellid: *Reniera* ? sp." Whilst neither figure nor description permit certainty, it is most probable that this represents a fragment of organic tissue (?plant). Plant fragments of similar appearance, some arcuate, were encountered with fair frequency.

11. "Tetractinellid: *Geodia ? austini* n. sp." This species was tentatively transferred to the genus *Systematophora* in an earlier paper (Sarjeant, 1964, p. 175). A specimen closely resembling the holotype is present in slide I (specimen IA: Pl. 1, fig. 10). From examination of both specimen and figure, there can be no question that this species is a junior synonym of *Hystrichosphaera ramosa* (Ehrenberg, 1838) O. Wetzel 1933, emend. Davey and Williams 1965a. The species name *austini* must therefore be rejected, under Article 63 of the "International Code of Botanical Nomenclature."

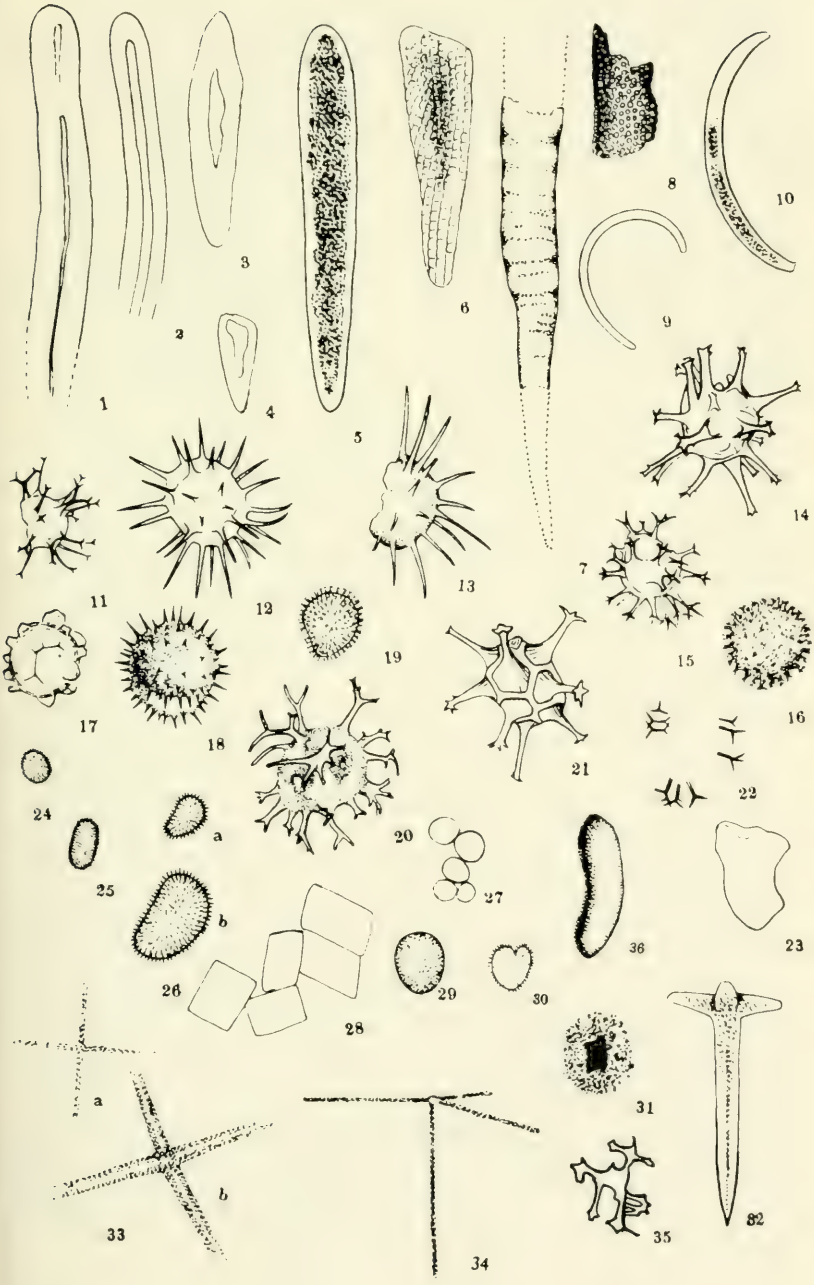
12. "Tetractinellid: *Geodia ? cretacea* n. sp." This species was transferred to the genus *Baltisphaeridium* in an earlier paper (Sarjeant, 1964). Several representatives of this species have been encountered in slide III. The holotype cannot be differentiated with complete certainty; the specimen most similar to the figure is specimen III J (Pl. 1, fig. 6). Hystrichospheres of this type are frequent in the Upper Cretaceous. Ehrenberg (1838) was the first to record such forms, applying the name *Xanthidium hirsutum*, which is that of a living desmid. Lejeune-Carpentier (1941) redescribed Ehrenberg's fossil material, under the name *Hystrichosphaeridium hirsutum*, but Deflandre (1946) correctly pointed out that the trivial name *hirsutum* could not be legitimately transferred to another genus and applied to the fossil forms. Deflandre had earlier (1937) proposed a new species *H. striolatum* for similar Upper Cretaceous forms having numerous slender, simple or branching spines, and a striate shell surface; there can be little doubt that Merrill's species *cretaceum* is a senior synonym of *striolatum*, although confirmation of the striate nature of the shell surface did not prove possible.

Under strict application of the rules of priority (Article 63 of the "International Code of Botanical Nomenclature") the name *cretaceum* is senior and should be retained; the name *striolatum* is junior and should be rejected. However, the species *striolatum* was soundly based, fully described and adequately figured; the species *cretaceum* was, in contrast, profoundly misinterpreted and inadequately figured and described. Moreover, complete certainty in the recognition of the holotype is not possible; and full

Text-figure A

A reproduction of Merrill's plate (1895). The specimens are here labelled according to the interpretation given in the present paper. Fuller discussions of the assignations are given in the text.

1-4. Shell fragments sectioned at varying angles.
5. A fragment of organic material.
6, 8. Wood fragments.
7. Shell lining of a unilocular foraminifer (?).
9. Character not clear.
10. Fragment of organic material.
11. *Hystrichosphaera ramosa* (Ehrenberg, 1838).
12. *Exochosphaeridium cretaceum* (Merrill, 1895) ≡ *E. striolatum* (Deflandre, 1937).
13. *Hystrichodinium pulchrum* Deflandre (?).
14. *Oligosphaeridium complex* (White, 1842).
15. *Hystrichosphaera ramosa* (Ehrenberg, 1838).
16. Spore.
17. Character not clear.
18. *Baltisphaeridium texanum* (Merrill, 1895).
19. *Chlamydophorella* sp. (?).
20. *Hystrichosphaera ramosa* (Ehrenberg, 1838).
21. *Hystrichosphaeridium tubiferum* (H. H. White, 1842).
22. Detached spines of *Hystrichosphaera ramosa* (Ehrenberg, 1838).
23–26. Character not clear.
27. "Brown bodies" of Bryozoa (?).
28. Carbonate crystals.
29. Dinoflagellate cyst, probably *Microdinium* sp. (?).
30, 31. Character not clear.
32–34. Probable sponge spicules.
35. Fragment of *Hystrichosphaera ramosa* (Ehrenberg, 1838) (?).
36. Fragment of organic material.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and accurate redescription of the holotype, even if certainly relocated, would not be possible because of the difficulty in studying chert-enclosed specimens at high magnification. The name *striolatum* is in widespread use; the name *cretaceum* has not been reused since its original publication, other than in taxonomic lists. Were a generic name concerned, an adequate case for conservation could be made under Article 14; unfortunately, this Article does not apply to species names. Nonetheless, it is here suggested that *striolatum* should continue to be used, in preference to the name *cretaceum*, in view of its more adequate description. The correct generic assignation is currently to *Exochosphaeridium* Davey, Downie, Sarjeant and Williams, 1966.

13. "Tetractinellid: *Geodia ? spini-curvata* n. sp." This species was transferred to the genus *Baltisphaeridium* in an earlier paper (Sarjeant, 1964, p. 175). No specimen comparable to the holotype or attributable, on grounds of general morphology, to this species, was encountered. The figure shows a form with relatively few, simple spines and having a precingular archaeopyle; it is probably referable to the genus *Hystrichodinium* Deflandre 1935 emend. Sarjeant 1965, perhaps to *H. pulchrum* Deflandre 1935, a species very frequent in English cherts. However, since the holotype is lost and since neither description nor figure permit certain statement of its characteristics, the species name *spini-curvatum* cannot continue in use.

14. "Tetractinellid: *Geodia ? irregularis* n. sp." This species was transferred to the genus *Hystrichosphaeridium* in an earlier paper (Sarjeant, 1964, p. 175). No specimen comparable to the holotype or attributable, on grounds of general morphology, to this species, was encountered. However, despite Merrill's statement (p. 15) that "Nothing similar to this has been found figured," there can be little doubt that this species is a junior synonym of *Oligosphaeridium complex* (H. H. White, 1842), Davey and Williams 1966a, a species frequent in the Cenomanian and known to range down well into the Lower Cretaceous.

15. "Tetractinellid: *Geodia ? tripunctata* n. sp." Rejection of this species on the grounds that it is a junior synonym of *Hystrichosphaera ramosa* (Ehrenberg, 1838) O. Wetzel 1933, emend. Davey and Williams 1966a, has already been proposed (Sarjeant, 1964, p. 175). A number of representatives of the species *H. ramosa* were encountered, including perhaps Merrill's holotype (specimen IIIC: Pl. 1, fig. 4); the earlier judgement is fully supported.

16. "Tetractinellid: *Hymeraphia* ? sp." The figured specimen was not found; however, Merrill's figure shows a trilete mark, indicating that his specimen was in all probability a spore. Spores and pollen occur infrequently in the chert sections; two somewhat similar forms are specimens IIIF (which resembles the figured specimens, but lacks a comparable clear trilete mark) and VIA (Pl. 1, fig. 5).

17. "Tetractinellid: *Chondrilla* ? sp." The figure and description of this form are so indefinite as to render impossible determination of its true character. One specimen encountered (IIC: Pl. 1, figs. 2, 3), a dinoflagellate cyst (questionably referable to the genus *Gonyaulacysta* and seen in oblique antapical view) may perhaps be Merrill's specimen, but this is incapable of confirmation.

18. "Tetractinellid: *Geodia? texana* n. sp." This species was transferred to the genus *Baltisphaeridium* in an earlier paper (Sarjeant, 1964, p. 175). Neither the holotype nor any comparable specimen was located; the morphology, as illustrated, is insufficiently characteristic to permit fuller comment on its probable affinities. Since the holotype is lost, a fuller analysis of the characteristics of the species is not possible; the name *texanum* cannot, therefore, continue in use.

19. "Tetractinellid: *Hymeraphia* ? sp." The figure is not especially informative, but shape, spine cover, and a faint indication of a cingulum combine to suggest a dinoflagellate cyst. The combination of characters strongly suggests a species of the genus *Chlamydophorella*; unfortunately, this probable assignation cannot be confirmed, since the figured specimen was not relocated.

20. "Tetractinellid: *Geodia? spinipansata* n. sp." This species was transferred to the genus *Hystrichosphaeridium* in an earlier paper (Sarjeant, 1964, p. 275). It is probable that a specimen encountered in slide III (specimen III B: Pl. 1, fig. 7) is the holotype. There can be no question that this is yet another specimen of *Hystrichosphaera ramosa* (Ehrenberg, 1838) O. Wetzel 1933, emend. Davey and Williams 1966a; this species shows some range of variation in morphology (cf. Davey and Williams, 1966a), and also varies in appearance according to orientation. The spines are not tubular, so that assignation to *Hystrichosphaeridium* is incorrect. The species *spinipansatum* must be rejected, as a junior synonym of *ramosa*.

21. "Tetractinellid: *Geodia? hilli* n. sp." This species was transferred to the genus *Hystrichosphaeridium* (Sarjeant, 1964). No specimen comparable to the holotype or attributable, on grounds of general morphology, to this species, was encountered. However, despite Merrill's repetition of his statement, earlier applied to No. 14, "Nothing similar has been found figured," the specimen he figures is without question attributable to the species *Hystrichosphaeridium tubiferum* (Ehrenberg, 1838) O. Wetzel 1933, emend. Davey and Williams 1966a, a species common throughout the Cenomanian and likely to be present in the Albian. The species *hilli* must, therefore, be rejected as a junior synonym of *tubiferum*.

22. "Tetractinellid: *Geodia tripunctata* ? n. sp. Fragments resulting from solution." Unquestionably these are detached spines of *Hystrichosphaera ramosa*. A number of such detached spines were seen, none corresponding precisely to the grouping shown in the figure, which might in any case be idealised.

23. "Lithistid ? Flesh spicule." This is described as "yellowish" and must be presumed to be a plant or wood fragment. The figure, by it generalised nature, precludes certain recognition; similar fragments were by no means uncommon.

24, 25, 26. "Tetractinellids; *Hymeraphia* ? sp." Over-simplified figures and descriptions again render certain recognition difficult. Pollen grains of comparable morphology were noted, and also (in slide X) a species of dinoflagellate cyst questionably attributable to the genus *Prolixosphaeridium* Davey, Downie, Sarjeant and Williams 1966, with a similarly elongate shape and cover of simple spines (Pl. 1, fig. 8).

27. "Tetractinellid: *Geodia* ? sp." Groups of circular, disc-like structures were encountered in several cherts (e.g. VII B; Pl. 1, fig. 11). Similar structures occur widely in palynological material from the Upper Mesozoic; Merrill's description (p. 17) is quite accurate. Their interpretation is doubtful; Otto Wetzel (1961, pl. 1, figs. 8-10) has figured similar forms as "brown bodies" of Bryozoa; it is also possible that they represent remains of colonial algae, possibly Chlorophyta.

28. "Tetractinellid: dermal spicules ?" These are abundant in most of the cherts examined and are undoubtedly rhomb-shaped carbonate (? dolomite) crystals. Carbonate crystals are frequently encountered in cherts and are sometimes considered to

indicate that the chert was formed by replacement of a pre-existing limestone. Merrill's misinterpretation of them is surprising (Pl. 1, fig. 12).

29. "Tetractinellid: *Geodia* sp." The figure may correspond to a specimen in slide III, which resembles it in general features (specimen IIIH). Although full study is difficult because of its situation deep in the chert, this is certainly a dinoflagellate cyst, and most probably a species of the genus *Microdinium*, species of which are known to occur in the Cenomanian.

30. "Tetractinellid: globo-stellate of dermal layer." This structure was not relocated and is of dubious reference, possibly pollen.

31. "*Geodia ?*" The figure and description are inadequate to permit recognition of this form.

32. "*Geodia* ? Pyramidal or zone spicule." Not relocated; most probably correctly interpreted as sponge spicules.

33, 34. "Hexactinellid. *Stauractinellia* ? sp." Not relocated; most probably correctly interpreted as sponge spicules.

35. "Frame work of a Hexactinellid?" This appears to be a fragment of a *Hystrichosphaera furcata*, although the figure is extremely generalised and precise interpretation is difficult. A similar fragment was encountered in slide III (specimen IIIE).

36. "Monactinellid: *Reniera* ? sp." The sausage-shaped object in Merrill's figure is most probably to be interpreted as a fragment of organic tissue (? plant); many similar fragments were seen.

CONCLUSIONS

A re-examination of Merrill's text and figures, in conjunction with study of the three surviving chert sections (one broken) and of new sections made from surviving fragments of cherts, makes it clear that, of the 36 microscopic structures he figures and describes, only three (none confirmed) can be regarded as representing sponge spicules. Nine of his figures certainly, and four others possibly, represent dinoflagellate cysts (mainly hystrichospheres); these include his eight proposed new species, of which five are junior synonyms of previously described species. The three remaining species retain technical validity, but the holotypes of two are lost, the descriptions and figures being insufficient to enable their accurate characterisation, and the holotype of the third species does not permit full study.

The remaining 20 microscopic structures figured and described by Merrill are of very diverse character. Four are considered to represent shell fragments sectioned in varying directions; one is thought to be a foraminiferal shell lining; one is a spore; three possibly pollen; one represents an association of disc-like structures, possibly "brown bodies" of Bryozoa; one comprises carbonate crystals; two represent wood fragments; four represent fragments of organic (? plant) tissue of varying shape; and three are of indeterminate character.

The currently valid species of dinoflagellate cysts recognised in Merrill's figures and material are *Hystrichosphaera furcata*, *Hystrichosphaeridium tubiferum*, *Exochosphaeridium striolatum*, *Oligosphaeridium complex*, *Hystrichodinium pulchrum* (doubtful), and undetermined species of the genera *Gonyaulacysta*, *Prolixosphaeridium*, *Hystrichodinium*, *Chlamydophorella* and *Microdinium*. Although the number of individuals encountered is small, and a full picture of the dinoflagellate cyst assemblage cannot be said to have been obtained, the species represented are all ones which would be likely to occur in Middle to Upper Albian preparations.

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Plate 1

Fig. 1. Presumed shell lining of a unilocular Foraminifer (Fig. 7 "Monactinellid" of Merrill). × 500.

Figs. 2, 3. *Gonyaulacysta* sp. indet., seen in oblique apical view (Fig. 2) and, by transparency, in oblique antapical view (Fig. 3) — the antapex is at left. Figure 2 closely resembles "Tetractinellid; *Chondrilla* ? sp." of Merrill. × 500.

Fig. 4. *Hystrichosphaera ramosa* (Ehrenberg). The presumed holotype of Merrill's invalid species *Geodia ? tripunctata.* × 500.

Fig. 5. *Hystrichosphaera ramosa* (Ehrenberg). Possibly the holotype of Merrill's invalid species *Geodia ? spini-pansata.* × 500.

Fig. 6. *Exochosphaeridium cretaceum* (Merrill). The specimen may be the holotype. × 500.

Fig. 7. *Hystrichosphaera ramosa* (Ehrenberg). A specimen in terminal view, illustrating the high degree of variation in appearance given by orientation. × 500.

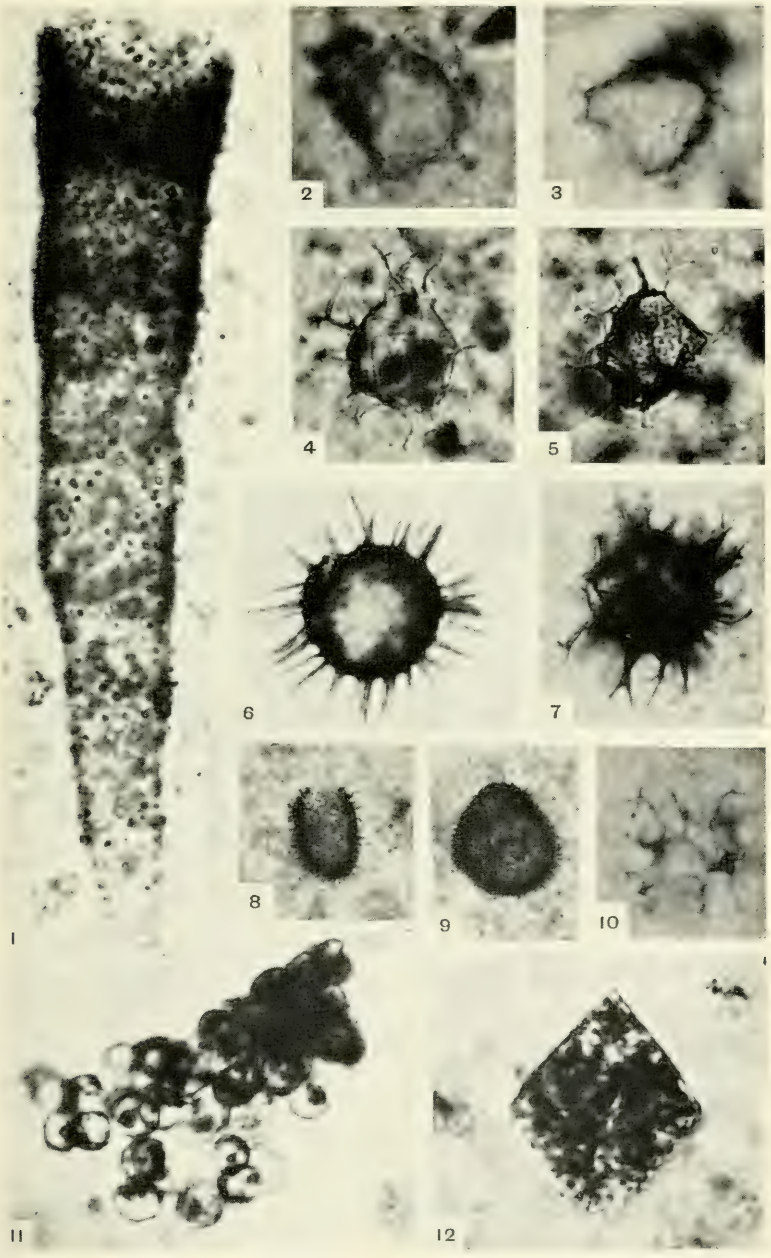
Fig. 8. *Prolixosphaeridium* sp. indet. (Possibly corresponding to Merrill's Fig. 26b "Tetractinellid; *Hymeraphia* ? sp."). × c300.

Fig. 9. Spore, gen. et sp. indet. (Similar to Merrill's Fig. 16 "Tetractinellid; *Hymeraphia* ? sp."; but lacking a clear trilete mark.) × c300.

Fig. 10. *Hystrichosphaera ramosa* (Ehrenberg). Possibly the holotype of Merrill's invalid species *Geodia ? austini.* × 500.

Fig. 11. Group of disc-like organisms, possibly "brown bodies" of Bryozoa (equivalent to Merrill's Fig. 27 "Tetractinellid; *Geodia* ? sp."). × 500.

Fig. 12. A carbonate (? dolomite) crystal. Similar crystals are described by Merrill as "Tetractinellid: dermal spicules?" × 500.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